REMARKS/ARGUMENTS

Status

This is in response to an Office action dated 9/28/2004.

Claims 1-20 are pending.

Claims 1-20 are rejected.

The drawings are accepted.

Claim Objections

Claims 11 and 15 are objected to because of the following informalities:

Regarding claim 11, the limitation "the strap is has" should be changed to read, "the strap [[is]] has".

Regarding claim 15, there is insufficient antecedent basis for the limitation "the node poly element". Appropriate correction is requited.

Claims 11 and 15 are canceled.

Applicant notes that claim 16 also needed correcting, and is also canceled.

Claim Rejections -35 USC § 102

Claims 1-20 are rejected under 35 U.S.C. 102(b) as being anticipated by Mandelman et al. (US Pat. 2002/0105019, hereinafter Mandelman).

Regarding claims 1 -3, Figure 6C and 6M of Mandelman disclose a DRAM cell comprising: a semiconductor substrate 10; a trench 16 extending into the substrate; a cell capacitor disposed in a bottom portion of the trench (paragraph [0051]); a cell transistor 24/32/36 disposed in a top portion of the trench above the cell capacitor; a node conducting element (upper portion of 22) connecting the cell capacitor to the cell transistor; and a collar 18 disposed about the node conducting element between the cell transistor and the cell capacitor; wherein: the collar is disposed in the substrate, wholly outside of the trench, between the cell capacitor and the cell

trench.

Regarding claims 15 and 16, Figures 6A-6M of Mandelman disclose for each DRAM cell, providing a node conducting element (upper portion of 22) between the cell capacitor and the cell transistor; wherein: the collar is disposed laterally adjacent and laterally surrounds the node poly element.

Regarding claims 17 and 18, Figures 6A-6M of Mandelman disclose for each DRAM cell, providing a node conducting element (upper portion of 22) between the cell capacitor and the cell transistor; and a strap 26 disposed between the node conducting element and the cell transistor, wherein the strap is self-aligned with the collar.

Regarding claim 19, Figures 6A-6M of Mandelman disclose a providing strap 26 disposed in the trench at substantially the same depth as the collar. Note that the strap and collar 18 are in contact. Therefore, at least the contact portions are at the same depth, and the two elements can be considered to be at substantially the same depth.

Claim Rejections -35 USC § 103

Claims 1-9 and 11-20 rejected under 35 U.S.C. 102(a) as anticipated by Tews et al. (US Pat. 6,599,798, hereinafter Tews) or, in the alternative, under 35 U.S.C. 103(a) as obvious over Tews in view of the admitted prior art.

Regarding claims 1-3 and 12-14, Figure 12 of Tews discloses a DRAM cell comprising: a semiconductor substrate; a trench extending into the substrate; a cell capacitor disposed in a bottom portion of the trench; a cell transistor (col. 5, lines 20-22) disposed in a top portion of the trench above the cell capacitor; a node conducting element (poly in trench, col. 5, lines 3-6); and a collar disposed about the node conducting element (col. 5, lines 5-7); wherein: the collar is disposed in the substrate, wholly outside of the trench, between the cell capacitor and the cell transistor. Tews discloses a vertical transistor is formed after the structure of Fig. 12 is completed (col. 5, lines 20-22). Therefore, it is believed that the node conducting element will connect the cell capacitor to the cell transistor through outdiffusion region 30 (which forms the source/drain of the transistor). If for some reason this is found to not be inherent, it would

transistor.

Regarding claims 4 and 5, Figure 6M of Mandelman discloses a strap 26 disposed between the node conducting element and the cell transistor, which is self-aligned with the collar.

Regarding claim 6, Figure 6M of Mandelman discloses a strap 26 disposed in the wench at substantially the same depth as the collar. Note that the strap and collar 18 are in contact. Therefore, at least the contact portions are at the same depth, and the two elements can be considered to be at substantially the same depth.

Regarding claims 7, 8, 11, and 20, Figures 6M of Mandelman discloses a strap 26 disposed in the trench and having a periphery; and the collar 18 is laterally adjacent and surrounds the periphery of the buried strap. As shown in Figures 6M and Figure 2 (showing the out-diffused region 24 which corresponds to the strap), the strap is formed on only one side of the trench, in an upper portion of the collar (see also paragraph [0054]), extending around the circumference of the trench. Therefore, it can be considered that the collar is laterally adjacent and surrounds the periphery of the buried strap, wherein the lateral direction is the direction around the circumference of the cylindrical trench.

Regarding claim 9, Figures 6C and 6M of Mandelman disclose a DRAM cell comprising: a semiconductor substrate 10; a trench 16 extending into the substrate; a cell capacitor disposed in a bottom portion of the trench (paragraph [0051]); a cell transistor 24/32/36 disposed in a top portion of the trench above the cell capacitor; a node conducting element (upper portion of 22) connecting the cell capacitor to the cell transistor; and a collar 18 disposed about the node conducting element between the cell transistor and the cell capacitor; and a strap 26; wherein the strap is embedded into a top surface of the collar (paragraph [0054]).

Regarding claim 10, Figure 6M of Mandelman discloses that the strap extends no higher than the collar.

Regarding claims 12-14, Figures 6A-6M of Mandelman disclose a method of forming DRAM cells, comprising: forming trenches 16 in a semiconductor substrate 10; forming cell capacitors in a bottom portion of the trench (paragraph [0051]); forming cell transistors 24/32/36 in a top portion of the trench; and for each DRAM cell, providing a collar 18 between the cell capacitor and the cell transistor, the collar being disposed in the substrate, wholly outside of the

certainly be obvious to have the node conducting element connecting the cell capacitor to the cell transistor as shown in Figure 1 of the instant application (prior art) for the purpose of fabricating a functional DRAM device. Regarding claims 12-14, Figures 2-12 also disclose a method of making the device.

Regarding claims 4, 5, and 18, Figure 12 of Tews discloses a strap 28 disposed between the node conducting element and the cell transistor, wherein the strap is self-aligned with the collar.

Regarding claims 6 and 19, Figure 12 of Tews discloses a strap 28 disposed in the trench at substantially the same depth as the collar.

Regarding claims 7 and 20, Figure 12 of Tews discloses a strap 28 disposed in the trench and laterally surrounded by the collar.

Regarding claim 8, Figure 12 of Tews discloses a strap 28 disposed in the trench and having a periphery; and the collar is laterally adjacent and surrounds the periphery of the buried strap.

Regarding claim 9, Figure 12 of Tews discloses a DRAM cell comprising: a semiconductor substrate; a trench extending into the substrate; a cell capacitor disposed in a bottom portion of the trench; a cell transistor (col. 5, lines 20-22) disposed in a top portion of the trench above the cell capacitor; a node conducting element (poly in trench, col. 5, lines 3-6); and a collar disposed about the node conducting element (col. 5, lines 5-7); a strap 28; wherein: the strap is embedded into a top surface of the collar. Tews discloses a vertical transistor is formed after the structure of Fig. 12 is completed (col. 5, lines 20-22). Therefore, it is believed that the node conducting element will connect the cell capacitor to the cell transistor through outdiffusion region 30 (which forms the source/drain of the transistor). If for some reason this is found to not be inherent, it would certainly be obvious to have the node conducting element connecting the cell capacitor to the cell transistor as shown in Figure 1 of the instant application (prior art) for the purpose of fabricating a functional DRAM device.

Regarding claim 11, Figure 12 of Tews discloses the strap has a periphery, which is laterally surrounded by the collar.

Regarding claims 15 and 16, Figure 12 of Tews discloses a node conducting element

between the cell capacitor and the cell transistor; wherein: the collar is disposed laterally adjacent to and surrounds a periphery of the node poly element.

Regarding claim 17, Figure 12 of Tews discloses a strap 28 between the node conducting element and the cell transistor.

Traversing the Rejections

The references relied upon are:

Pat. 2002/0105019 (Mandelman)

US Pat. 6,599,798 (Tews)

Admitted prior art (APA) is also mentioned.

According to the invention , generally, in a DRAM cell having a trench, a cell capacitor and a cell transistor, a node conducting element connects the cell capacitor to the cell transistor and a collar is disposed about the node conducting element. The collar is disposed in the substrate at least partially, up to entirely outside of the trench. Because the collar is disposed in the substrate outside of the trench, it does not restrict the size of the trench opening. This enables sub-100nm trenches, using techniques which are compatible with contemporary DRAM process steps. A strap is embedded into a top surface of the collar. (See Abstract)

A novel feature of the present invention is that the buried strap (248) is laterally surrounded by the buried collar (244). See, for example, FIG. 2I, and refer to the following text.

> [0052] Next, the exposed portion of the oxide structure 220 is etched to form a recess 242 in the top inside corner of the oxide structure 220. The oxide 220 may be etched by buffered hydrofluoric acid (BHF). The oxide structure 220 with the recess 242 is referred to hereinafter as the collar (or "buried collar") 244. The collar 244 is disposed laterally adjacent and surrounds the periphery of the top portion of the node conducting element 236. The resulting interim structure is shown in FIG. 2H.
>
> [0053] ... The collar 244 is disposed at least partially, preferably substantially,

and more preferably wholly (entirely) outside of the trench, in the substrate, within the sidewall of the trench.

[0054] Next, the buried strap (BS) 248 (compare 128) is fabricated. The buried strap is a thin (e.g., 300 Angstroms) layer of undoped or arsenic-doped polysilicon in the cavity 242. It can be deposited thick and etched back (fill and recess). It covers the top surface of the node conducting element 236, and extends into the recess 242 in the top inside corner of the collar 244, as is illustrated ...

[0055] Here a difference can readily be noted between the present invention and the prior art. In the DRAM cell (e.g., 100) of the prior art, the strap 128 is disposed entirely atop the collar 138, and has substantially the same width as the collar 138. The outside surface of the strap 128 is adjacent the substrate 102. In the DRAM cell of the present invention, the strap 248 is self-aligned to, and embedded in the top surface of the buried collar 244; that is, it extends no higher than the collar (it is fully vertically embedded/buried in the collar) and it is laterally surrounded by the collar. The strap is disposed in the trench at substantially the same depth as the collar, with the exception that the collar extends deeper into the trench and covers the bottom surface of the strap. The collar 244 of the present invention is laterally adjacent and surrounds the outside surface (periphery) of the buried strap 248. The collar also covers the bottom surface of the strap. The outside surface of the strap 248 is not adjacent the substrate 202.

[0056] ... Generally speaking, upward diffusion of the strap towards the cell transistor is desired.

[0057] ... outward diffusion of the strap 248 of the present invention is constrained by the laterally-surrounding collar 244. This is useful for suppressing BS-to-BS interaction when two DRAM cells are disposed closely adjacent each other.

[0058] ... downward diffusion of the strap 248 of the present invention is

constrained by the collar 244. This is useful for increasing trench capacitance due to the relaxed requirement on collar length.

[0059] ... the upper surface of the buried strap 248 should not extend above the upper surface of the buried collar 244.

Neither the 6,599,798 nor the 2002/0105019 references do not disclose this feature. On the contrary, the buried strap is on top of the collar in these two references. See Figure 12 of 6,599,798 and Figure 6E of 2002/0105019. Such a non-constrained buried strap in prior art has the disadvantage of excessive dopant out diffusion from the buried strap. 2002/0105019 addresses this issue by forming a divot filled with insulator next to the buried strap (Element 40 in Figure 6I). Note that the element 40 and the collar 18 are two separate elements formed in the different step of the process. The laterally surrounded buried strap by collar is distinct from the prior art.

The claims are amended to reflect the patentable features discussed above. More particularly:

Independent Claim 1 is amended to include limitations comparable to those in claim 8 (canceled).

a strap disposed in the trench and having an outside peripheral surface; and

the collar is laterally adjacent and surrounds the outside peripheral surface of the buried strap.

Claim 8 is canceled.

Independent claim 9 is amended to depend from claim 1, and is direced to "the strap is embedded into a top surface of the collar". In claim 10, the strap extends no higher than the collar.

New Claim 21-1 adds the limitation of:

a recess disposed in a top inside corner of the collar; and

the strap extends into the recess in the top inside corner of the collar.

New Claim 22-1 adds the limitation of:

the strap is fully vertically embedded in the collar and it is laterally surrounded by the collar.

New claim 23-1 adds the limitation of:

the strap is disposed in the trench at substantially a same depth as the collar; and

the collar extends deeper into the trench than the strap and and covers a bottom surface of the strap.

New claim 24-1 adds the limitation of:

the collar covers a bottom surface of the strap.

Independent claim 12 is amended to include the limitation of:

for each DRAM cell, forming a recess in a top inside corner of the collar; and

for each DRAM cell, embedding a strap in the recess.

New claim 25-12 is directed to the feature of:

constraining outward diffusion of the strap by the laterally-surrounding collar; and

constraining downward diffusion of the strap with the collar.

New claim 26-12 is directed to the feature that

an upper surface of the buried strap does not extend above an upper surface of the collar.

All of the amendments and additions made to the claims are fully supported either by the original claim or the specification, particularly those parts of the specification quoted hereinabove.

Claim Count

The application was filed with 20 total claims, 3 of which were in independent form.

Six claims (9, 11, 15, 16, 17, 18) are canceled herewith.

Six claims (21-26) are entered herewith.

One of the independent claims (9) is amended to be in dependent form.

There remain 20 total claims, 2 of which are in independent form.

No fee is required.

Conclusion

The claims should be allowed.

No new matter is entered by this amendment.

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

Howard M. Cohn
Reg. No. 25,808

CERTIFICATE OF TRANSMISSION BY FACSIMILE

I hereby certify that this correspondence is being transmitted to the United States Patent and Trademark Office (Fax No. 703-872-9306) on December 16, 2004.

Name of Person Signing Certificate : Howard M. Cohn
Signature :
Date of Person signing : December 16, 2004

C:\IBM\IBM-102\IBM-102 1am.doc